

A STUDY ON THE ANTI-BACTERIAL PROPERTY OF ESSENTIAL OILS AND METAL OXIDES IN DENIM GARMENTS

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ABSTRACT

This research aims to analyse the anti-bacterial properties of essential oils (rose oil and citrus oil) and metal oxides (titanium dioxide and zinc oxide) in denim garments. The fabric selected for the research was 2/1 Right Hand Twill cotton denim fabric. The selected fabric was made into prototype garments and subjected to pre treatments. Subsequently the garments were treated with agents like essential oils (rose oil and citrus oil) and metal oxides (titanium di oxide and Zinc oxide) by two different methods – direct exhaustion and micro encapsulation methods. The garments were tested for the efficacy of anti-bacterial property qualitatively by agar diffusion method. The results have proven very good inhibition against the bacteria in conjunction with a sweet fragrance in case of essential oils.

KEYWORDS: Anti-Bacterial Finish, Denim, Enzyme Washing and Essential Oils

INTRODUCTION

“Denim is one of the world’s oldest fabrics, yet it remains eternally young”. The word denim is an Americanization of the French name "serge de Nimes," a fabric which originated in Nimes, France during the middle ages. "Denim is ever fashionable fabric that is both fashion and performance driven". The inherent properties of the textile fibers provide room for the growth of micro-organisms [1]. The increasing awareness for hygienic lifestyle, effects of global warming are raising necessity and expectation in consumers for a wide range of textile products finished with antimicrobial properties, UV protection, stain release etc. [2, 3]. Inorganic materials such as metal and metal oxides have attracted lots of attention over the past decade due to their ability to withstand harsh process conditions [4, 5]. Of the inorganic materials, metal oxides such as TiO₂, ZnO, MgO and CaO are of particular interest as they are not only stable under harsh process conditions but also generally regarded as safe materials to human beings and animals [6]. The natural oils are widely used in the industry of toiletries, cosmetics, perfumes etc. Recently the application of essential oils in textiles has been increasing as it imparts a pleasant, new-clothing odor which can mask unpleasant odors and is similar in action to a deodorant. The scents of lavender, rose, citrus or vanilla were encapsulated into fabrics which proved a good way to meet important psychological and emotional needs [7].

METHODOLOGY

The 2/1 Right hand twill denim fabric has been selected for this research. The denim fabric is cut and made into simple sleeveless denim tops, since denim processing is done at the garment stage. Three mediums were selected for inhibiting anti-bacterial effect in denim like essential oils (combination of rose and citrus oils), TiO₂ and third one is ZnO.

Twelve garments were developed and the preparatory process like desizing and enzyme washing was carried out. After pre treatments these were divided into two equal parts for further functional finishing (six garments - direct exhaustion method and six - micro encapsulation method). This is further subdivided into three groups (two garments in each group). First division was treated with combination of essential oils (50 rose oil: 50 citrus oil), second group in TiO_2 and third with ZnO by direct exhaustion method. The same was followed in microencapsulation method as well.

Treatments

The Prototype garments developed were subjected to Enzymatic desizing process for removal of size particles. The process was carried out using 0.5 gm/L non-ionic wetting agent, 0.5 gm/L Bio-Tempasel (desizing enzyme) at temperature 65 – 70 °C for 20 minutes. The MLR was maintained as 1:20. The desized garments were washed and rinsed twice after the process. This was followed by Enzyme bio-wash to soften the denim. In this study commercially available cellulase enzyme was used to bio-wash denim garments. During bio-wash pH was maintained in between 5 and 5.5, temperature 55-60 °C; the MLR was maintained as 1:15. The bio-wash was carried out for 30 minutes.

Application of Metal Oxides and Essential Oils to Denim Garments

The desized and bio washed garments were again divided into 3 equal parts (2 garments in each part) and it was subjected to functional finishing using three different components like titanium dioxide, zinc oxide and essential oils. The metal oxides (titanium dioxide and zinc oxide) were synthesised into nano particles, since many studies have proved its efficacy only in nano size and the essential oils (sweet citrus and rose oil) were commercially purchased from a private firm in Bangalore. Three baths were prepared for TiO_2 , ZnO and combination of the essential oils. Two methods were adopted for the study like direct exhaustion and micro encapsulation.

Direct Method

The garment samples prepared was treated with prepared solution of TiO_2 , ZnO and essential oils (2 garments in each bath). The fabric was immersed for 30 minutes in the prepared solution. After 30 minutes, the fabric was removed, rinsed (single time), squeezed and dried at 80 – 85 °C in the oven for 5 minutes and cured at 150 °C for 2 minutes.

Microencapsulation Method

The nano TiO_2 , ZnO and essential oils were microencapsulated using sodium alginate. Microcapsules were prepared employing sodium alginate, 3% sodium alginate was prepared and 2% nano metal oxides were added separately. This was sprayed into calcium chloride solution by means of a sprayer. The droplets were retained in calcium chloride for 15 minutes. The microcapsules were obtained by decantation and repeated washing with Isopropyl alcohol followed by drying at 45 °C for 12 hours. The microcapsules were then used for finishing on the selected fabrics by the same exhaustion method.

Antibacterial Test

The antibacterial test was done using the agar diffusion method (SN 195920). The untreated control fabric and treated fabric samples were placed in close contact with AATCC bacteriostasis agar (*Staphylococcus aureus* and *Escherichia coli*). In Agar diffusion method Bacteriostasis agar was dispensed in sterile petriplates. 24 hours broth cultures of the test organisms (*E. coli* and *S. aureus*) were used as inoculums. Using sterile cotton swab the test organisms were swabbed over the surface of the agar plates. The test fabrics (fabrics treated TiO_2 , ZnO and essential oils) & Control fabric

(untreated) was gently pressed in the center of the mat culture. The plates were incubated at 37°C for 18-24 hours. After incubation, it was analysed by visual examination and also under a microscope (X 40 magnification). The evaluation was made on the basis of absence or presence of an effect of bacteria in the contact zone under the specimen and the possible formation of a zone of inhibition around the test specimen. The area of inhibition zone is a measure of antimicrobial effectiveness.

RESULTS AND DISCUSSIONS

The treated fabrics were tested for the inhibition of *Staphylococcus aureus* and *Escherichia coli* using agar diffusion method and the results of the qualitative antibacterial assessment by agar diffusion is shown in Table 1.

Table 1: Antibacterial Assessment by Agar Diffusion Method

S. No.	Method	Type of Bacteria	Zone of Inhibition (mm)		
			Essential Oils	TiO ₂	ZnO
1	Direct method	<i>Staphylococcus aureus</i>	34	42	40
		<i>Escherichia coli</i>	30	32	32
2	Micro encapsulation method	<i>Staphylococcus aureus</i>	26	30	33
		<i>Escherichia coli</i>	22	24	26

From the Table 1 it is very much clear that the direct exhaustion method shows greater inhibition to the anti-bacterial property when compared to that of the microencapsulation method. In case of direct method, in all the three agents used shows better inhibition action for *S. aureus* than *E. coli* and it is the same in case of micro encapsulation methods as well. The performances of the treated fabrics against the bacteria are illustrated in the Figure 1 (essential oils treated denim fabrics), figure 2 & figure 3 (TiO₂ treated denim fabrics) and figure 4 (ZnO treated denim fabrics).

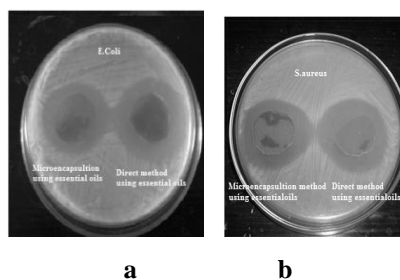


Figure 1: Anti Bacterial Activity in Essential Oils Treated Denim Fabric – (a) against *Staphylococcus aureus* by Direct and Microencapsulation Method (b) Against *Escherichia Coli* by Direct and Microencapsulation Method

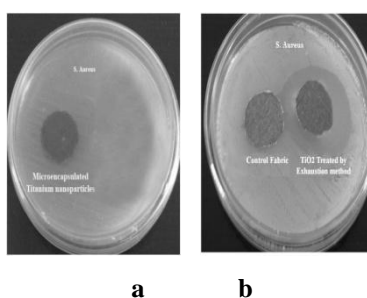


Figure 2: Anti Bacterial Activity against *Staphylococcus aureus* in TiO₂ Treated Denim Fabric – (a) Control Fabric and Fabric Treated by Exhaustion Method (b) Fabric Treated by Microencapsulation Method

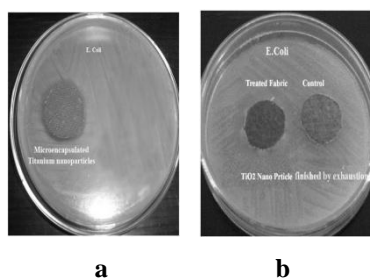


Figure 3: Anti Bacterial Activity against Escherichia Coli in TiO_2 Treated Denim Fabric - (a) Control Fabric and Fabric Treated by Exhaustion Method (b) Fabric Treated by Microencapsulation Method

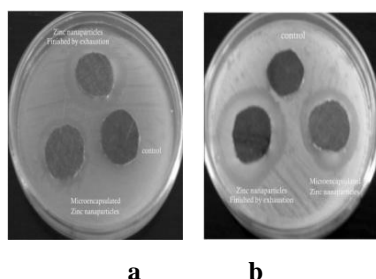


Figure 4: Anti Bacterial Activity in ZnO Treated Denim fabric – (a) Against Staphylococcus aureus by Direct and Microencapsulation Method (b) Against Escherichia Coli by Direct and Microencapsulation Method

CONCLUSIONS

The increase in the expectations of the consumer in a product has paved the path for value addition. In line with this they want their apparel to perform multi functional activities other than the aesthetic performance. Many prior studies have proved the anti-bacterial property in cotton fabrics by the application of zinc oxide and titanium oxides. In this research work a novel attempt has been taken to analyse the efficiency of natural oils with respect to anti-bacterial property. The study proves that the metal oxides show slightly better results than essential oils, but with regard to health hazards and other societal issues it is always better to opt for eco-friendly products for obtaining functional properties in apparel. The initial inhibition factor of the bacteria is less in microencapsulation method when compared to the direct method; this may be due to the slow rupture of the materials from the core of the capsules.

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